

# Appendix B

## Operational Safety Procedures

# Lawrence Livermore National Laboratory

## Operational Safety Procedure L-52

### Cleanup Of Ground Water Contaminated With Gasoline By Using The Dynamic Underground Stripping Process

#### 1.0 Reason for Issue

This operation is not covered by the *Health & Safety Manual* or other existing safety structure. Therefore, this Operational Safety Procedure has been prepared to document the controls necessary to adequately address the safety concerns of this operation.

#### 2.0 Work to be Done and Location of the Activity

- 2.1 Work to be Done: The Dynamic Underground Stripping project has demonstrated the rapid removal of underground organic contamination (gasoline, in this case) using monitored steam injection and electrical heating. The first application of this process was conducted by cleaning up a gasoline spill at the site of the old LLNL gasoline station. At the LLNL site, gasoline leaking from underground storage tanks has contaminated the ground both below the water table and in the vadose zone.

Electrical heating of the subsurface is accomplished by injecting currents in the ground from electrodes placed either on the surface or in bore-holes, thereby heating those segments of the ground which steam will not penetrate. Voltages as high as a few hundred volts and currents up to a few hundred amperes per electrode are used for this purpose.

Periodic water level measurements is taken from piezometer wells located near the steam injection wells. It is possible for the piezometer wells to be pressurized through subsurface formations by injected steam. The piezometer well heads are constructed from schedule 40 steel pipe and capped with a pressure gauge, pressure relief valve and an access plug.

Maintenance of down-hole extraction pumps or other down-hole equipment may be required during steam injection operations.

- 2.2 Location: This OSP covers operations to be conducted at the gasoline contaminated site (the Gas Pad) which is located near Building 406.

- 2.3 Hazardous Materials Involved: Saturated steam (at 150 psig and 360°F) and gasoline which is present in both liquid and vapor phases during extraction. The gasoline contains benzene, which is a known carcinogen.

### 3.0 Responsibilities

- 3.1 Bill Siegel (Ext. 2-0390) is responsible for the safety of this operation and for assuring that all work is performed in conformance with this OSP and applicable sections in the *Health & Safety Manual* and *Environmental Protection Handbook*. In the absence of Bill Siegel, Roger Aines (Ext. 3-7184) shall assume these responsibilities.
- 3.2 Mike Buettner (2-7888) is responsible for the safety of the Electrical Ground Heating portion of this operation and for assuring that all work is performed in conformance with this OSP and applicable sections in the *Health & Safety Manual* and *Environmental Protection Handbook*. In the absence of Mike Buettner, Bill Daily (2-8623) shall assume these responsibilities.
- 3.3 Any changes in operations that improve or do not significantly affect safety and environmental controls may be approved by the Authorizing Individual for this OSP and the ES&H Team Leader. The Responsible Individual shall ensure that this action is documented in a memorandum. Any changes in operation that increase the hazard level, introduce additional hazards, or decrease safety shall not be made until a revision of or supplement to this OSP has been reviewed and approved consistent with the review and approval process for the original OSP.
- 3.4 All individuals operating under the auspices of this Operational Safety Procedure (OSP) are required to initially sign the OSP Review Form (Appendix A) as indication of their acceptance and understanding of the conditions of this OSP.

### 4.0 Hazards Analysis

#### 4.1 General Site Operations Hazards:

- 4.1.1 Dynamic Underground Stripping is a highly energetic process using pressurized steam and large electrical currents to mobilize and remove gasoline contaminants from the ground. Gasoline vapors may be present in the vicinity of well heads and effluent treatment equipment. Personnel will be required to do equipment maintenance and monitoring and take periodic measurements during the operation.
- 4.1.2 Gasoline contains up to 10% quantities of benzene, an OSHA-regulated carcinogen, due to its association with leukemia, as well as other blood disorders. Leaded gasoline, the type spilled at the Building 406 site, also

contains <10% quantities of ethylene dibromide, a CAL/OSHA regulated and National Toxicology Program (NTP) listed non-target organ specific carcinogen. Other components of gasoline may individually or collectively cause both acute and/or chronic central nervous system effects. During piezometer well measurements and well maintenance, there is a potential for inhalation exposures to benzene, ethylene dibromide, and gasoline component vapors. If vapor concentrations reach or exceed the Lower Explosive Limit (LEL) there is the potential for explosions or fires.

- 4.1.3 In addition, skin contact with gasoline components, as with other organic solvents, can remove essential oils from the skin, causing localized inflammation, cracking, and/or bacterial infections, referred to collectively as solvent dermatitis.

Agent	Permissible Exposure Limit (PEL)	Short-Term Exposure Limit (STEL)	Reference <sup>(1)</sup>
Benzene	1 ppm, 8 hr TWA <sup>(2)</sup> 0.1, 8 hr. TWA <sup>(4)</sup>	5 ppm, 15 min. avg - - - - -	29 CFR 1910.1028 ACGIH Intended Change for 1993-1994
Ethylene dibromide	ALARA <sup>(3)</sup>	ALARA	ACGIH

Note:

- (1) Per DOE Order 5480.4
- (2) 8-hour time weighted average exposure
- (3) "As Low As Reasonably Achievable," per ACGIH guidelines for suspected human carcinogens.
- (4) Confirmed Human Carcinogen

## 4.2 Steam Injection Hazards:

- 4.2.1 Steam will be generated by a commercially available portable steam boiler. The capacity of the boiler at the gas pad will be rated at a maximum of 24,000 LB/hr. The boiler will be fired by natural gas. The maximum allowable working pressure (MAWP) of the steam injection system will be 150 Psi. Steam will be injected into the ground at 50 to 75 Psi.
- 4.2.2 The failure of the steam system piping could cause severe burns and other injuries to nearby personnel.
- 4.2.3 Exposure to pressurized steam and related steam equipment could cause severe burns.
- 4.2.4 Ground water brought to the boiling point by the steam injection process could form a bubble beneath the column of water collected in the well. The

steam bubble could force the column of water above it up the well casing causing a geyser effect at the surface when the well head cap is removed. The experience at the clean site has shown that a well can be quenched by adding cold tap water to the well, eliminating the venting of steam and water from the well head. The addition of 1,000 gallons of water to the well quenched it for 75 minutes. The well was quenched indefinitely by the continuous addition of water (at the rate of approximately 10 gpm) while the well head was open.

#### **4.3 Electrical Hazards:**

- 4.3.1 The hazard associated with electrical heating of the ground is the potential for electrical shock or explosion resulting from the electrical connections in the presence of gasoline vapors. The electrical hazard can be either direct or indirect. A direct hazard is one associated with the power generating or handling equipment on the surface. An indirect hazard is one associated with a contact to the ground surface or subsurface.

#### **4.4 Electrical Resistance Tomography (ERT) Hazards:**

- 4.4.1 The hazard associated with Electrical Resistance Tomography (geophysical imaging) is the potential for electrical shock or explosion resulting from the electrical connections in the presence of gasoline vapors. The electrical hazard can be either direct or indirect. A direct hazard is one associated with the power generating or handling equipment on the surface. An indirect hazard is one associated with a contact to the ground surface or subsurface.

### **5.0 Controls**

The controls specified below will reduce risk to employees and the environment to acceptable levels:

#### **5.1 General Site Operations Controls:**

- 5.1.1 The designated Site Safety Manager shall have full responsibility and authority with respect to all site operations.
- 5.1.2 A perimeter fence, a minimum of 6 feet high, shall be constructed around the area where steam injection and/or electrical heating is being conducted, establishing a "controlled" area. Personnel working inside this controlled area are required to first check in with the Site Safety Manager in Trailer 4107 prior to entering the area. The Site Safety Manager shall inform the personnel of ongoing activities in the controlled area and of any hazards they should be aware. Personnel working in the area shall wear PPE as established by the ES&H Team.

- 5.1.3 Visitors to the area shall be escorted by project personnel and shall wear safety glasses and hard-hats (only required during construction activities) when inside the perimeter fence, and other personal protective equipment required of workers in areas they are visiting or inspecting.
- 5.1.4 The Site Safety Manager shall conduct operational safety discussions at the start of each day's activities with individuals working in the area. The intent of these discussions will be to identify any safety issues pertaining to the previous day's operations or upcoming activities. A "Status Board" shall be maintained in Dynamic Stripping office trailer by the Site Safety Manager noting the status of equipment, operational issues, and the safety hazards personnel should be aware of.
- 5.1.5 Smoking shall not be permitted inside the fenced 406 gas pad area due to the possible presence of gasoline vapors. An adequate number of "NO SMOKING" signs shall be posted throughout the project area.
- 5.1.6 The following minimum personal protective clothing requirements are necessary for personnel working inside the controlled area:
- Safety shoes
  - Safety glasses
  - Hard-hats (only required during construction activities)
  - Hearing protection (as deemed necessary by the ES&H Team)
  - Tyvek coveralls (as specified in following controls)
  - Full face respirator (as specified in following controls)
  - Medium weight nitrile gloves (as specified in following controls)
- 5.1.7 Additional safety equipment that is required relating to specific operations (i.e., well maintenance, electrical heating, etc.) is given in the appropriate sections that follow.
- 5.1.8 First aid kits, eyewash stations, and fire extinguishers shall be available on site at all times. Eyewash stations shall be available within 10 seconds travel time and 100 feet of unobstructed travel in all areas where chemical splash may occur.
- 5.1.9 Warning signs with the following wording shall be placed on the perimeter fence so that they are clearly visible from any approach: "DANGER: BENZENE, CANCER HAZARD, FLAMMABLE -- NO SMOKING, AUTHORIZED PERSONNEL ONLY."

## **5.2 Steam Injection Controls:**

- 5.2.1 Steam equipment and associated piping are installed according to LLNL standards set forth in References 3 through 9. All hook-ups and piping connections prior to operation shall be made by certified LLNL pressure installers in accordance with appropriate codes and LLNL procedures (Ref. 2).
- 5.2.2 The steam boiler is a standard, commercially available unit, which is self contained on flatbed trailers. It is built and tested according to ASME boiler codes that satisfy LLNL requirements. The boiler shall have a design operating pressure of 300 psig with two pressure relief valves set at 300 psig. An additional pressure relief valve shall be installed on the distribution manifold exiting the boiler set at the Dynamic Stripping Operation steam injection pressure (MAWP) of 150psig. The hook-up of natural gas, water, electrical utilities, and steam distribution piping shall be done by qualified LLNL employees (or their contractors) in accordance with LLNL standards and specifications.
- 5.2.3 All piping, valves and gauges are commercially available hardware rated for steam service at a minimum of 150 psig.
- 5.2.4 Warning signs with the following wording shall be placed on the perimeter fence so that they are clearly visible from any approach reading: "Danger: High Pressure Steam and Underground Electrical Currents May be Present. Entry By Authorized Personnel Only."
- 5.2.5 Personnel access inside the perimeter fence shall be permitted during operation of the steam equipment to check on the operation of the boiler and to collect operating data (i.e., flow rates, etc.). Entry into the controlled area is governed by the conditions set forth in General Site Operational Controls (5.1). The boiler shall be manned continuously during operation.

## **5.3 Electrical Controls:**

- 5.3.1 A controlled area around the electrical heating test shall be established by fencing the area with a well-grounded fence at least 6 feet high (as defined in the General Site Safety section). Such fences shall have good electrical contact with the ground at intervals not to exceed 10 to 15 feet.
- 5.3.2 "Danger: High-Voltage" signs shall be placed on the fence so they are clearly visible from any approach.
- 5.3.3 Access inside the fenced area shall be controlled by the responsible individuals or trained designated alternates with the concurrence of the Site Safety Manager. Access gates into the controlled area shall be interlocked so that the source of electrical power shall be shut off if personnel enter the area. The perimeter fence shall be located a minimum of 8 feet from any

energized bore-hole (i.e., a bore-hole with electrical heating electrodes) and a minimum of 2 feet from any well with subsurface thermocouples or other electrical instruments, or other electrical conductors such as metal pipes in contact with the subsurface. Monitoring wells outside the perimeter fence that have subsurface electrical conductors shall be completed below grade in Christy boxes.

- 5.3.4 Above grade electrical connections to wells outside the perimeter fence (i.e., thermocouple wires) shall be disconnected and placed inside the perimeter fence prior to the start of electrical heating.
- 5.3.5 A Responsible Individual or a designated trained alternate shall be on site at all times when work is being conducted within the controlled area and electrical heating wells are energized. Designated alternates shall have met the training requirements noted below. The system may be monitored by an individual not meeting the training requirements noted below providing the following conditions are met:
  - a. A responsible individual or trained designated alternate shall be on call.
  - b. The monitoring individual shall be familiar with this OSP.
  - c. The monitoring individual shall not enter the controlled area. His or her only task shall be to monitor the operation from outside the controlled area.
  - d. There is no other activity on the site.
  - e. In the event of a malfunction, the individual shall shut off all power using a remote kill switch. Malfunctions shall be reported immediately to the responsible individual on call.
- 5.3.6 While electrical heating is taking place, no individual shall be allowed into the controlled area alone. Two or more individuals may enter the controlled area while electrical heating is being conducted, providing that the proper clothing is worn (see 5.3.18 below) and they have had the proper training (See 7.3, Electrical Heating Training Requirements below).
- 5.3.7 Before routine operations begin, the responsible individuals shall measure and record voltages outside of the controlled area to determine if there is a shock hazard. The measurements shall be taken during "off hours" (nominally 7:00 p.m. to 6:00 a.m.) to minimize personnel in the vicinity. The following measurements shall be made:
  - a. Between any buildings, trailers or equipment chassis and ground.



- b. Between scientific equipment, thermocouples, other electrical conductors, etc., in contact with the ground and ground.
  - c. Between points six feet apart on the ground in the direction of expected maximum gradient; i.e. the extension of the line between probes should pass through the center of the heating electrode array.
  - d. Between the perimeter fence and ground.
- 5.3.8 A potential shock hazard shall be assumed to exist if the potential measured exceeds 10 VAC. If such a hazard is found, electrical power to the heating wells shall be shut off until the hazard is eliminated or is included inside the controlled area.
- 5.3.9 Electrical equipment (i.e. transformers, etc.) in the controlled area shall be electrically grounded at all four corners of the equipment by a grounding rod driven at least 8 feet into the ground.
- 5.3.10 All electrical connections shall be made by qualified electricians. Electrical equipment within three feet of the oil-water separators shall conform to NFPA explosion proof Class 1 Division 1. Electrical equipment between 3 and 10 feet of the oil-water separators shall conform to NFPA explosion proof Class 1 Division 2.
- 5.3.11 Wiring shall be sized to handle the maximum credible current loads and be properly sheathed for use in the expected environment to protect against rodent intrusion or damage from physical contact or puncture.
- 5.3.12 Fused circuits are required for all wiring. Breakers are to be sized according to the current capacity of the wiring.
- 5.3.13 Flashing red beacons shall be on when the field in the controlled area is energized.
- 5.3.14 Subsurface drilling shall not take place within 100 feet of any electrode during electrical heating.
- 5.3.15 Steam injection piping shall be electrically isolated from the well heads during electrical heating.
- 5.3.16 Electrode water supply lines shall not overlap one another. Three separate water supply reservoirs shall be used to wet electrodes, one reservoir for each phase of three phase power. Cross wetting of wells at different phases from a single reservoir shall not be allowed.

5.3.17 Lockout and Tagout procedures, as specified in the LLNL *Health & Safety Manual*, Supplement 26.13, shall be used whenever the power generating equipment is shut off for maintenance or operational requirement.

5.3.18 In addition to the protective clothing specified in the General Site Operational Controls (Section 5.1), personnel working in the controlled area while the power is on shall wear high-voltage gloves and electrically non-conductive safety shoes.

5.3.19 A copy of this OSP and the Electronics Engineering Department's Electrical Safety Policy, LED 61-00-01-A1A, shall be posted in the work area at all times.

#### 5.4 Electrical Resistance Tomography (ERT) Controls:

5.4.1 Personnel wishing to make ERT measurements shall request permission from the Site Safety Manager prior to starting.

5.4.2 The Site Safety Manager shall verify that no other downhole activities (i.e., temperature measurements, well maintenance, etc.) are being conducted in the ERT wells that will be energized. He shall inform personnel already on the site that ERT measurements are about to be taken and that other downhole activities in the energized ERT wells are not permitted for the duration of the ERT measurements.

5.4.3 Personnel taking ERT measurements shall inform the Site Safety Manager when they are done and the ERT system is de-energized.

#### 5.5 Piezometer Well Data Measurement Controls:

Personnel taking measurements from the piezometer well shall follow the following procedure:

5.5.1 In addition to the protective clothing specified in the General Site Operational Controls (Section 5.1), personnel shall wear face shields and nitrile protective gloves.

5.5.2 Obtain permission from the Site Safety Manager to proceed. Unnecessary personnel shall be cleared away from the area prior to starting.

5.5.3 Note well head pressure.

5.5.4 Slowly crack the pressure relief valve open until the pressure begins to decrease. (Steam is directed away from personnel.)

5.5.5 Allow the pressure to drop slowly to zero. DO NOT attempt to open the well head cap to take measurements until zero pressure is indicated.

- 5.5.6 Remove the well head cap.
- 5.5.7 Sample breathing zone area using a Photo-ionization detector setup for benzene sampling. If measurements exceed two-times background then follow:
- a. All personnel working within the regulated work area shall don appropriately fitted full-face piece respirators equipped with organic vapor cartridges and Tyvek coveralls.
  - b. The ES&H Team 4 Industrial Hygienist shall be immediately notified.
  - c. An air sample shall be collected and submitted for immediate analysis by gas chromatography.
  - d. A "Respirators Required" sign shall be posted at each entrance to the regulated work area.
  - e. NOTE: Real-time benzene exposure measurements shall be collected as an indicator of exposure to other organic chemicals.
- 5.5.8 If no background levels are detectable, an action level of 5 ppm shall be used to trigger above requirements.
- 5.5.9 Full face piece respirators equipped with organic vapor cartridges shall be worn if benzene concentrations exceed either the eight-hour time weighted average permissible exposure limit (PEL) of 1 ppm or the 15-minute short term exposure limit (STEL) of 5 ppm.
- 5.5.10 If directed by the ES&H Team, personnel samplers shall be worn by designated field personnel. During specific activities judged by the technical staff to cause the highest levels of benzene or ethylene dibromide, air samples shall be collected from the field personnel's breathing zone. The sample collected shall then be analyzed by gas chromatography for benzene in order to determine if the airborne concentration exceeds the STEL of 5 ppm.
- 5.5.11 Proceed with measurements.
- 5.5.12 After measurements are taken, verify that the ball valve is in the full open position.
- 5.5.13 Replace the well head cap.
- 5.5.14 Close the pressure relief valve.

## **5.6 Well Maintenance Controls**

Personnel conducting maintenance on a well shall follow the following procedure:

- 5.6.1 In addition to the protective clothing specified in the General Site Operational Controls (Section 5.1) personnel shall wear eye goggles and nitrile gloves prior to beginning the well opening operation.
- 5.6.2 Obtain permission from the Site Safety Manager to proceed. Clear unnecessary personnel away from the area prior to starting.
- 5.6.3 Attach a water supply hose to the quench port on the side of the well head.
- 5.6.4 Open the quench port valve and let water flow into the well (approximately 10 GPM for ten minutes).
- 5.6.5 Verify that the well head is not pressurized. If the well head is pressurized, vent the pressure through the pressure relief valve slowly and wait for a zero pressure reading before proceeding.
- 5.6.6 Remove the well head cap.
- 5.6.7 Proceed with maintenance operations. Let water continue to flow into the well at a slow rate. Increase the water flow rate if there are any indications of steam vapor venting.
- 5.6.8 Close the well head as soon as is reasonably possible. The well head shall not be left unattended if it is opened.

## **6.0 Environmental Concerns and Controls**

- 6.1 The Bay Area Air Quality Management District (BAAQMD) has issued an exemption for the boiler which allows the unit to operate for a total of 60 days. Once this operating time limit has been used, the boiler must be shutdown until a permit, new exemption, or extension to the existing exemption has been obtained for the boiler.
  - 6.1.1 The boiler must be operated with a firing rate of less than 33 million BTU per hour to comply the exemption condition.
  - 6.1.2 The boiler will be equipped with a Zurn low NO<sub>x</sub> burner. NO<sub>x</sub> emissions will be 40 PPM or less in accordance with BAAQMD regulations.

- 6.2 Three waste streams are associated with the boiler operation at the gas pad. The first is a city water discharge from the process de-aeration tank. This is overflow water from a tank which serves as a reservoir for water which is chemically de-oxygenated. The approximate discharge is 125 gallons/hour.
- 6.2.1 The second waste stream is brine water from the zelite bed-regeneration. This will generate a discharge of about 350 gallons every 24-36 hours at a peak rate of 60 gpm.
- 6.2.2 The third waste stream is from the boiler blow-down. The boiler is used for steam in the well-head injection process to allow the pollutants to move through the soil and be pumped to the surface. This discharge is estimated to be approximately 100 gallons/day.
- 6.2.3 The City of Livermore Water Reclamation Plant must approve the discharge of waste water from these three processes to the sanitary sewer system. At least one month prior notification to the EPD waste water responsible person is necessary to coordinate such discharge approvals.
- 6.2.3.1 All discharges to the sanitary sewer will be made during high sanitary sewer flow periods. This limits discharges to weekday business hours only (9:00 am to 4:00 PM). During off work hours and weekend, no waste water shall be discharged to the sanitary sewer. All waste water will be collected in an appropriate container and held until the next business day.
- 6.2.3.2 All three discharges to the sanitary sewer must be hard piped and allow for representative sampling of the waste stream prior to discharge.
- 6.2.3.3 Adequate tank capacity must be provided to allow for containment of one cycle of zelite-bed regeneration waste water without discharging to sanitary sewer. The tank(s) will be used to collect the initial waste water from the regeneration process to allow a representative sample to be taken and hold the waste water until the analytical results have been received.
- 6.2.3.4 The responsible waste water representative (or designee) must be present prior to all sampling events for each of these three waste streams to ensure proper sampling techniques are being performed. This will also ensure that representative samples are taken, appropriate paper work is completed (e.g., chain of custody, waste analysis request), and no disconnects occur with the sampling data. Since pH is of concern, a portable pH meter shall be used to record results in a logbook prior to the sample being discharged.

6.2.3.5 The responsible waste water representative must be contacted prior to initial discharge of each waste stream. Subsequent discharges should be monitored on a periodic basis by the waste water representative.

6.2.3.6 A logbook shall be maintained on the site to record the following information for each discharge: waste water pH, time, date, and volume discharged for each waste stream.

## 7.0 Training

7.1 In addition to the requirements listed below, personnel must have read, be familiar with, and comply with this OSP, OSP 406.2, Bore-hole Drilling in Gasoline Contaminated Areas, and OSP 406.4, Treatment of Vapors Ground Water Using Treat Facility F (TFF) conditions.

HS-4050 - "Health Hazards Communication" -- including chemical specific training for benzene and ethylene dibromide.

HS-1640 - "Cardiopulmonary Resuscitation (CPR)" repeated every 2 years.

7.2 All personnel who generate hazardous waste are required to attend the following Environmental Protection Department course within 6 months of hire or change in job position requiring handling of hazardous waste, and shall attend this course annually thereafter:

EP-0006 - "Hazardous Waste Handling Practices"

It is permissible for personnel who have not attended the required course to work under the direction of a person who has completed the course for an interim period, not to exceed 90 days.

7.3 Personnel working on the site who may come in contact with the gasoline must have CERCLA/SARA Health and Safety training.

7.4 Boiler operators must complete the following training (Ref. *Health & Safety Manual*, M-010, Chapter 32, Section 32.02):

HS-5030 - "Pressure Safety Orientation" (retraining is required every five years)

HS-5040 - "Intermediate-Pressure Safety" (retraining is required every five years)

- 7.5 Prior to beginning an electrical heating test, anyone working in the controlled area while it is energized must have completed the following training:

- HS-1640 - "Cardiopulmonary Resuscitation (CPR)" repeated every 2 years.
- HS-5220 - "Electrical Hazards Awareness" (Recommended) (retraining is required every five years)
- HS-5230 - "High-Voltage Awareness" (retraining is required every five years)

## 8.0 Maintenance

- 8.1 The boiler will be blown down at the end of each shift to remove sedimentary deposits from the bottom of the boiler. The LLNL water department will provide the chemicals (sodium bisulfate and sodium hydroxide) to maintain proper pH and oxygen content of the boiler feed water. Project personnel will provide rock salt for the water softening equipment.

## 9.0 Quality Assurance

- 9.1 Boiler safety systems will be checked prior to the start of routine operations by LLNL boiler operators. Specific items to be checked are itemized in the "Boiler Test Report" used by LLNL boiler operators. In addition to the startup checks, the 'low water' cut off switches will be tested once daily by program personnel. A boiler checklist will be maintained by the site safety manager, for boiler blowdown and low water tests and initialed by the technician conducting the test.
- 9.2 Electrical heating interlock switches will be checked before the start of routine operations. Testing will be accomplished by energizing the electrical heating pattern then shutting the system down by opening the interlock switch. The test will be repeated for each interlock or emergency kill switch in the area. An electrical heating interlock checklist will be maintained by the site safety manager, and initialed by the technician conducting the test.
- 9.3 Gloves shall be tested for pinholes daily and shall be electrically tested yearly.

## 10.0 Emergency Response Procedures

- 10.1 In the event of a serious injury, personnel will administer first aid and call 911 for emergency assistance. All work related injuries shall be reported to

the Responsible Individuals so that appropriate action may be taken as soon as is reasonably possible.

## 11.0 References

- 1) LLNL Operational Safety Procedure 406.2, *Borehole Drilling in Gasoline Contaminated Areas*.
- 2) LLNL Operational Safety Procedure 406.4, *Treatment of Vapors and Ground Water Using Treatment Facility F (TFF)*.
- 3) LLNL Health & Safety Manual, M-010.
- 4) LLNL Department of Mechanical Engineering, *Design Safety Standards Manual*, M-012.
- 5) DOE Pressure Safety Guidelines, M-089, Rev. 7.
- 6) LLNL Plant Engineering Safety Note, PE-92-406-1, *Dynamic Underground Stripping Project Steam Injection System at the Gas Pad*.
- 7) ASME Boiler and Pressure Vessel Code, Section 1.
- 8) California Code of Regulation, Title 8, Division 1, Chapter 4, Subsection 2, *Boiler and Fired Pressure Vessel Safety Order*.



# Lawrence Livermore National Laboratory

## Operational Safety Procedure

No: 406.2

### Borehole Drilling In Gasoline Contaminated Areas

#### 1.0 Reason for Issue

Personnel working in and around drilling operations may come in contact with sediments and ground water contaminated with gasoline. Gasoline vapors contain benzene, a human carcinogen.

#### 2.0 Work to be Done and Location of the Activity

2.1 Work to be Done: Drilling boreholes in gasoline contaminated soil and ground water for the installation of equipment, monitor and extraction wells and well development.

2.2 Location: Work to be done within a 100 yard radius of Building 406.

#### 3.0 Responsibilities

3.1 R. W. Bainer (Ext. 2-4635) is responsible for the safety of this operation and for assuring that all work is performed in conformance with this OSP and applicable sections in the *Health & Safety Manual* and *Environmental Protection Handbook*. In the absence of R. W. Bainer, J. Duarte (Ext. 3-2638) shall assume these responsibilities.

3.2 Any changes in operations that improve or do not significantly affect safety and environmental controls may be approved by the Authorizing Individual for this OSP and the ES&H Team Leader. The Responsible Individual shall ensure that this action is documented in a memorandum. Any changes in operation that increase the hazard level, introduce additional hazards, or decrease safety shall not be made until a revision of or supplement to this OSP has been reviewed and approved consistent with the review and approval process for the original OSP.

3.3 All individuals operating under this Operational Safety Procedure (OSP) are required to initially sign the OSP Review Form (Appendix A) as indication of their acceptance and understanding of the conditions of this OSP.

## **4.0 Hazards Analysis**

### **4.1 Drilling Operations:**

Personnel working in and near drilling rigs are exposed to a variety of potential mechanical hazards including: moving machinery, high pressure lines (e.g. hydraulic lines), unsafe use of cranes, flying machinery parts, drilling through underground utilities, falling objects, and unsafe walking and working surfaces. The consequences of accidents involving these physical hazards can range from minor to fatal injury.

### **4.2 Electrical:**

Electric power is often supplied by gasoline or diesel engine generators. Working conditions may be wet and electrical shock with possible fatal consequences may occur. In addition, it is possible that drilling operations may encounter buried electrical utilities, potentially resulting in exposure to very high-voltages which could be fatal and initiate fires.

### **4.3 Material Handling:**

Lifting of heavy and bulky equipment and boxes on and off trucks at emplacement locations is required. Physical injury, particularly back and crushing injuries, may occur.

### **4.4 Gasoline and Gasoline Components:**

Drillers, geologists, samplers and support personnel may come in contact with sediments, ground water and drilling fluids which have been contaminated with varying concentrations of hazardous materials including gasoline. Benzene is a component of gasoline and could constitute as much as 10% by volume. Water being purged from boreholes or wells in the area may contain free product gasoline. There is potential exposure of personnel working in the area to gasoline and vapors containing benzene. Ignition sources in the area may cause fire if concentrations reach the LEL.

Exposure to benzene and gasoline vapors at high concentration may cause severe depression of the central nervous system, coma and death. At lower levels, symptoms of intoxication may occur. Exposure to benzene vapor, or skin contact with the liquid may increase the risk of leukemia and other cancers. Skin contact can also cause dermatitis.

### **4.5 Other Airborne Contaminants:**

4.5.1 Silica flour, a small particle-size form of crystalline silica, is occasionally a component of the water-based grout introduced into the wells during and after drilling. During mixing of the grout, there is a low to moderate

potential for exposure to airborne silica dust. Inhalation of silica dust can result in silicosis, the formation of fibrotic or nodular scar tissues within the lungs. In general, silicosis is a result of long-term exposures, although at extremely high exposure levels, acute silicosis has been observed. Both the Permissible Exposure Limit (PEL) and the Threshold Limit Value for crystalline silica is 0.1 mg/m<sup>3</sup>.

- 4.5.2 Graphite powder is occasionally introduced directly into the well during drilling. Overexposure to airborne respirable graphite may cause pneumoconiosis. The TLV for graphite is 2 mg/m<sup>3</sup> (respirable fraction).

4.6 Underground Utilities:

Drilling operations may encounter buried utilities including gas and electrical lines. Drilling into electrical lines may potentially result in exposure to very high-voltages that could be fatal and initiate fires. Drilling into gas lines may potentially result in an explosion.

4.7 Noise:

Drilling equipment is capable of producing sound levels in excess of 85 dBA, the 8-hour Threshold Limit Value recommended by the American Conference of Governmental Industrial Hygienists (ACGIH) and adopted by LLNL.

4.8 Drill Movement:

There is potential to strike personnel, building(s) or other objects when maneuvering drilling rigs.

4.9 Heat Stress:

The use of Tyvek coveralls significantly increases the potential for drilling personnel to experience heat stress. Adverse effects from heat stress include heat cramps, dehydration, skin rash, heat edema, heat exhaustion, heat stroke or death.

5.0 **Controls**

The controls specified below will reduce risk to employees and the environment to acceptable levels.

- 5.0.1 Most of the hazards listed in section 4.0 are addressed in the LLNL *Health & Safety Manual*, the Environmental Restoration Program Standard Operating Procedures, and the Environmental Restoration Series Site Safety Plan. Personnel involved in drilling operations are familiarized with these

documents before work begins so that each worker understands the portions of the documents pertaining to the particular operation.

5.0.2 Operations and procedures shall comply with 29 CFR 1910.120 - "Hazardous Waste Operations and Emergency Response."

5.0.3 The designated Drilling Supervisor shall be responsible for safe working conditions, and shall halt work if site conditions are deemed unsafe. Drilling operations shall not be resumed until the unsafe conditions have been corrected. In addition, daily safety meetings shall be conducted by the Drilling Geologist prior to the commencement of drilling operations to highlight specific safety concerns particular to the day's operations. Each safety meeting shall be documented as to topics discussed and personnel in attendance.

5.0.4 Each operation shall be conducted in accordance with the Laboratory's "Working Alone" policy as defined in the *LLNL Health & Safety Manual*, Section 26.15. In the event that it is necessary for individuals to work alone under any circumstance, the Drilling Supervisor shall ensure that, at a minimum, adequate communications are maintained and that other persons are aware of the itinerary, intended work locations and estimated return time of the persons working alone.

## 5.1 Drilling Operations:

5.1.1 All subcontractors working on and around drilling rigs shall be properly trained to work on these rigs by their companies in accordance with LLNL standards.

5.1.2 At a minimum, workers are required to wear level D protective clothing, which includes hard hats, gloves, safety glasses, and steel-toed shoes. Neoprene or nitrile rubber gloves shall be used when free product gasoline is encountered. In addition, personnel shall wear disposable coveralls (Tyvek or equivalent) to reduce the potential for clothing contamination. Samplers and other support personnel may wear disposable aprons rather than coveralls. The Drilling Geologist shall be responsible for the enforcement of personal protective clothing requirements.

5.1.3 Only trained operators shall be used for drilling operations. In addition, the safe use of drilling machinery shall be highlighted during the daily safety meeting. All hoses operating under pressure shall be securely tethered to prevent whipping in the event of separation.

5.1.4 Workers required to climb drilling masts to perform maintenance and repairs are required to wear safety belts and/or lanyards and be tied off throughout the process. All workers required to work on the mast of the

drilling rig shall be properly trained in the use of safety belts and lanyards by their companies to conform with LLNL standards. This training shall be documented and auditable.

- 5.1.5 An exclusion zone shall be clearly marked with barricades and/or taping where only those persons associated with the sampling and safety personnel are admitted. No smoking shall be allowed in the area. Signs bearing the following legend will be clearly posted at entrances to the area:

**DANGER  
BENZENE  
CANCER HAZARD  
FLAMMABLE-NO SMOKING  
AUTHORIZED PERSONNEL ONLY  
RESPIRATOR REQUIRED**

The normal sign statement "RESPIRATOR REQUIRED" shall be covered with paper or tape unless the condition of 5.4.8 below is met.

- 5.1.6 Open boreholes shall be covered and/or secured when unattended, including crew breaks.

5.2 Electrical:

All electrical systems used during drilling operations shall be checked for proper grounding and proper installation prior to commencing operations.

5.3 Material Handling:

Workers are instructed in safe handling and lifting practices. Operations involving lifting equipment shall utilize operators trained in the use of such equipment. Two-man lifts shall be used when unusually sized or heavy lifts are made.

5.4 Gasoline and Gasoline Components:

- 5.4.1 The appropriate Health and Safety Technician and Environmental Analyst shall be notified prior to the commencement of any new drilling operations.
- 5.4.2 Material Safety Data Sheets (MSDSs) and/or Hazardous Substance Information Forms (HSIFs) for all hazardous chemicals including gasoline and benzene shall be kept at Building 406. All personnel working under this OSP shall be informed of the location of these documents.
- 5.4.3 No sources of ignition or open flame shall be permitted in the designated work area.

- 5.4.4 Intrinsically Safe Class I Division I fans shall be installed at the drill site to aid in air circulation.
- 5.4.5 A combustible gas indicator meter shall be kept at the drill site and shall remain "ON" during drilling operations. Whenever the lower explosive limit (LEL) readings exceed 20% of the LEL at the opening of the borehole, operations shall be suspended until readings are reduced by either increasing fan speed or increasing the number of fans and Fire Safety Personnel are notified. No spark generating machinery shall be in operation if 20% of LEL is reached.
- 5.4.6 Protective clothing and equipment specified by Hazards Control for the operation shall be made available for, and used by all personnel working under this OSP. At the minimum, the protective equipment specified in Section 5.1.2 shall be worn by all personnel working under this OSP.
- 5.4.7 The Drilling Geologist shall conduct employee breathing zone monitoring, as well as monitoring of the drill cuttings, using a photoionization detector equipped Organic Vapor Monitor (OVM) and/or a flame-ionization detector equipped Organic Vapor Analyzer (OVA). When evaluated using an OVM equipped with a 10.0 eV lamp and an instrument response setting of 1.0, the Drilling Geologist shall suspend drilling operations, when breathing zone readings exceed twice background levels, or in the absence of background levels, 5 ppm. If testing instruments other than a 10.0 eV lamp equipped OVM are used, instrument response shall be set to provide equivalent or greater sensitivity and scaling.
- 5.4.8 In the case that drilling operations are suspended for elevated breathing zone sample results, the Drilling Geologist shall immediately notify the Drilling Supervisor. The Drilling Supervisor shall, in turn, notify the ES&H Team. Drilling operations shall remain suspended until alterations to procedures and/or additional personal protective equipment are agreed upon. Procedure changes may include:
- 5.4.8.1 Institution of short-term and full-shift personal monitoring using passive dosimeters and/or active air samplers. Sampling shall be conducted by or under the direction of the ES&H Team Industrial Hygienist.
- Additional personal protective equipment may include:
- Half-mask or Full-face piece respirators equipped with organic vapor cartridges.
- 5.4.9 A liquid sample of the effluent from the borehole, split into two aliquots if directed by the analytical laboratory, shall be collected daily. The sample(s)

shall be analyzed for a fingerprint of the gasoline mixture as well as a fingerprint of the benzene component.

- 5.5 Half or full-face piece respirators equipped with High Efficiency Particulate Air (HEPA) filters shall be worn during all handling of dry grout mixtures or graphite powder. The use of combination organic vapor/HEPA filter cartridges is acceptable for this application.

5.6 Underground Utilities:

Prior to commencement of drilling, private contractors shall locate underground utilities. If these utilities interfere with the drilling operation, then the designated LLNL Drilling Supervisor shall relocate the borehole to avoid any possibility of disrupting these utilities.

5.7 Noise:

- 5.7.1 Whenever new or previously unevaluated drilling equipment is used, the drilling geologist shall contact ES&H Team 4 to obtain a noise survey. Noise survey results from previous borehole drilling operations indicate sound levels in excess of 85 dBA within approximately 50 feet of some auger and air drill rigs. A controlled area must be maintained at this distance around the drilling rig with a posting at each entrance to the controlled area to read:

**CAUTION  
NOISE HAZARD  
Hearing Protection Required**

- 5.7.2 Participation in a hearing conservation program is required for employees routinely exposed to noise levels exceeding 85 dBA. Visitors in the area for less than one hour may enter the controlled area without hearing protection.

5.8 Positioning Drilling Rig:

The safe maneuvering of the drilling rig will be addressed at the initial (and periodically thereafter) employee safety meeting.

5.9 Heat Stress:

- 5.9.1 The Drilling Geologist is responsible for monitoring employees for indications of heat stress. The ES&H Team 4 Industrial Hygienist will perform heat stress measurements and provide heat stress control consultation.
- 5.9.2 When heat stress conditions exist, the following must be made available:

- At least one large fan for direct air movement at the driller's work position;
- A cool and shaded rest area;
- Regular rest breaks; and
- An adequate supply of drinking water.

## **6.0 Environmental Concerns and Controls**

- 6.1 Drilling cuttings shall be disposed of according to the Environmental Protection Department's Environmental Restoration Series Standard Operating Procedures, dated July 1990.
  - 6.2 All containers used for storage of drill cuttings and fluids shall be properly labeled as Hazardous Waste and stored in the designated waste accumulation area. Gasoline (free product) shall be removed from the "mud tub" as soon as visible signs occur and placed in labeled containers.
  - 6.3 All gasoline that is collected shall be disposed of as hazardous waste through Hazardous Waste Management. No visible gasoline shall be left in the "mud tub" at the end of the work day.
  - 6.4 Open boreholes, when not actively being drilled, shall be protected from surface water, rain water or other potentially contaminated fluids entering and contaminating soil and ground water.
  - 6.5 Fluids leaking to the ground from the drilling rig such as fuel, hydraulic fluid and engine coolant shall be contained, collected, placed in a waste container, and identified with the appropriate waste label. Typically these fluids are managed with a disposable catch pan and absorbent materials and should be disposed of as drilling debris through Hazardous Waste Management.
  - 6.6 Drill cuttings and fluids shall be sampled and analyzed as required for off-site disposal.
- ## **7.0 Training**
- 7.1 LLNL employee Supervisors are required to complete HS-4050, "Health Hazards Communication."
  - 7.2 All LLNL employees routinely exposed to noise levels exceeding the ACGIH TLV and/or required to wear hearing protection on the work site shall complete HS-4360, "Noise."



- 7.3 All personnel who generate hazardous waste are required to attend the following Environmental Protection Department course (this course must be requested):

EP-0006 - "Hazardous Waste Handling Practices"

It is permissible for personnel who have not attended the required course to work under the direction of a person who has completed the course for an interim period, not to exceed 90 days.

- 7.4 Contractors shall have equivalent training for the above listed courses provided through their companies.
- 7.5 Personnel involved shall have received at a minimum the 40 hours of CERCLA/SARA health and safety training pursuant to the requirements of 29 CFR Section 1910.120, and the annual 8 hour refresher course if applicable. Employees shall have completed 24 hours of supervised field training. Supervisors must also receive 8 hours of additional training as described in 29 CFR 1910.120.
- 7.6 The Responsible Individual shall ensure that all required training, including on-the-job training, if applicable, is complete and documented.

#### **8.0 Maintenance**

- 8.1 All field monitoring equipment shall be calibrated as specified in the Site Safety Plan, LLNL Document Number UCRL-21174 dated July, 1989.
- 8.2 Drilling equipment shall be maintained by the drilling subcontractor.

#### **9.0 Quality Assurance**

Quality Assurance requirements are detailed in the Quality Assurance Project Plan LLNL Ground Water Project UCAR #10219 dated June, 1989.

#### **10.0 Emergency Response Procedures**

Contractors are responsible for providing first aid and medical assistance to their employees if they are injured or become ill. The emergency telephone number for Medical Assistance and the Fire Department is 911. All injuries and accidents shall be reported promptly to the Drilling Supervisor. Hazards Control shall also be notified as soon as possible.

## 11.0 References

Environmental Restoration Program Standard Operating Procedures, July, 1990.

LLNL Environmental Restoration Division, ERD Quality Assurance Plan, Rev. 0

Quality Assurance Project Plan - LLNL Ground Water Project UCAR 10219, June, 1989

LLNL *Health & Safety Manual*, Supplement 10.08, "Noise - Its Evaluation and Control"

# Lawrence Livermore National Laboratory

## Operational Safety Procedure

No: 406.4

### Treatment Of Vapors And Ground Water Using Treatment Facility F (TFF)

#### 1.0 Reason for Issue

Proposed operations are not covered by an existing FSP or OSP.

#### 2.0 Work to be Done and Location of the Activity

- 2.1 Work to be Done: Ground water and vapors from the subsurface will be extracted and treated. Concentration of gasoline in liquid or vapor phase can reach 100%. Temperature may be up to 200° F. Treatment system is detailed on Plant Engineering drawing number PLM 92-406.

Liquid stream will be extracted and treated with a multistage process at up to 100 gpm. The liquid (ground water contaminated with gasoline up to 100%) will be pumped from wells with a pneumatic, positive displacement pump or centrifugal pump. The liquid stream will be cooled to below 115°F using an air cooled heat exchanger. Air in the liquid stream will be separated in a tank (air/water separator) and the air passed through carbon. Free product (100% gasoline) will be removed using an oil/water separator. Separated gasoline will be stored. Ground water at this point is expected to contain a maximum of 15 mg/L of gasoline. Particulate filters (5 micron) will remove silt from the ground water. A turbidity meter will monitor for break-through of free product (gasoline).

The ground water is then treated with an ultra violet (UV) hydrogen peroxide oxidation reactor. Hydrogen peroxide (50%) is stored in a 200 gallon doubly contained tank. Hydrogen peroxide is injected into ground water by a positive displacement pump to a concentration of 50 to 200 mg/L. The UV light splits the hydrogen peroxide in ground water into hydroxyl radicals. The high oxidation potential of the hydroxyl radicals allows oxidation of 99.8% of the remaining gasoline. Residual concentrations of 1,2-DCA and ethylene dibromide are left due to incomplete oxidation of these saturated compounds. Air stripping of these remaining contaminants will be accomplished by forcing 2,100 cfm of air through an air stripping tank. Effluent air from this tank will be passed through a carbon filter. We shall operate the facility at optimal conditions so that the treated water will have concentration of total contaminants below 5 µg/L. The water will be

transferred to a baker tank(s) and then pumped to the main laboratory cooling towers to be used as make up water.

Vapor stream of up to 4,000 cfm from the wells will be cooled to 80-90° F by a water cooled condenser (heat exchanger). A demister tank follows the condenser to separate water mist. Liquid water and gasoline, collected in a condensate tank will be pumped to the water treatment system. Non-condensed air and vapors are treated by a vapor extraction system (VES) using carbon with steam regeneration, specification ERD91-0001 (Ref. 11.3) or an internal combustion engine. The VES has a blower which extracts vapors at up to 425 cfm. The vapor stream passes through a carbon filter which adsorbs the gasoline. When contaminant break through of the carbon is detected, the influent vapor to the carbon is shunted to a second carbon filter. The first carbon filter is steam regenerated. The steam is condensed and gasoline is separated and stored for recycle or disposal by HWM. The internal combustion engine oxidizes the gasoline vapors. Both are permitted by the BAAQMD.

Operation of this facility includes monitoring the status, maintaining and cleaning extraction and treatment equipment and sampling liquid and vapor. Accumulated gasoline may be transferred to additional holding tanks and later removed by gasoline recycle contractor or by hazardous waste management. Dynamic Stripping is the process which mobilizes gasoline in the subsurface by electrical resistance heating and injecting steam into the ground. Operations performed for Dynamic Stripping are controlled by OSP L-52 (Ref. 11.2).

2.2 Location: The gasoline spill area near Building 406.

2.3 Hazardous materials and maximum amount at the facility follow:

Material	Amount
Gasoline Vapor	275 lb.
Gasoline liquid (free product)	1,000 gal
Ground water contaminated with gasoline in treatment facility	2,400 gal
Ground water contaminated with gasoline in Baker tanks	40,000 gal (start-up testing only)
Hydrogen Peroxide (50%)	<700 gal
Natural Gas	1 lb.

### 3.0 Responsibilities

- 3.1 Ed Folsom (Ext. 2-0389) is responsible for the safety of this operation and for assuring that all work is performed in conformance with this OSP, and applicable sections in the *Health & Safety Manual* and *Environmental Protection Handbook*. In the absence of Ed Folsom, Jerry Duarte (Ext. 3-2638), Ben Johnson (Ext. 4-4451) or Dennis White (Ext. 4-4451) shall assume these responsibilities.
- 3.2 Any changes in operations that improve or do not significantly affect safety and environmental controls may be approved by the Authorizing Individual for this OSP and the ES&H Team Leader. The Responsible Individual shall ensure that this action is documented in a memorandum. Any changes in operation that increase the hazard level, introduce additional hazards, or decrease safety shall not be made until a revision of or supplement to this OSP has been reviewed and approved consistent with the review and approval process for the original OSP.
- 3.3 All individuals operating under this Operational Safety Procedure (OSP) are required to initially sign the OSP Review Form (Appendix A) as indication of their acceptance and understanding of the conditions of this OSP.
- 4.0 **Hazards Analysis**
- 4.1 Fire/Explosion:
- 4.1.1 Fire or explosion may occur if air with a concentration of gasoline or a component of gasoline within the explosive limits is in contact with an ignition source. This could result in serious injury or death to personnel and/or serious damage to LLNL equipment.
- 4.1.2 Extracted ground water typically contains 20 ppm gasoline. The approximate composition of this gasoline is: Benzene 10%, toluene 11%, ethylbenzene 5%, xylenes 23%, Trichloroethylene (TCE) 0.9%, 1,2-dichloroethane (1,2-DCA) 0.3%, ethylene dibromide (EDB) 0.06% and other fuel hydrocarbons 50%. Composition of vapors in air will vary due to different rates of condensation/evaporation. A Lower Explosive Limit (LEL) of 1% and an Upper Explosive Limit of 8% generally are conservative limits for this suite of chemicals. Concentration of gasoline in air can be within these limits where free product is present or if the gasoline concentration in ground water is high enough. A worst case assumption for vapor concentration in equilibrium with ground water is that total hydrocarbons are either benzene, ethylbenzene, toluene or xylene (BTEX) because these are the most volatile compounds. For BTEX vapor concentration to reach the LEL in a confined space, the required concentration in ground water is 120 mg/L.
- 4.1.3 Vapors in excess of the LEL may occur within the extraction wells, in the piping to the oil/water separators including the ground water heat exchanger

and air/water separator. This condition may also occur within the condenser, demister, vapor extraction system (VES), condensate return tank and piping from these components to the liquid treatment system. The oil/water separator and gasoline storage tank(s) may also contain flammable concentrations of gasoline vapor. The oil/water separator has a lid which must be opened to visually check for proper operation. Vapors are exposed to atmosphere at this location only for treatment equipment. Operations outside of this OSP (Ref. 11.2) may produce gasoline vapors in the vicinity of treatment equipment.

#### 4.2 Chemicals -- Inhalation:

During maintenance operations, there is a potential for inhalation exposures to benzene, ethylene dibromide, and gasoline component vapors. This may occur during maintenance operations on all components of the treatment facility. Gasoline recovered from the subsurface contains up to 10% fraction as benzene, an OSHA-regulated carcinogen, due to its association with leukemia, as well as other blood disorders. The gasoline also contains 0.06% fraction as ethylene dibromide, a CAL/OSHA regulated and National Toxicology Program (NTP) listed non-target organ specific carcinogen. Other components of gasoline may individually or collectively cause both acute and/or chronic central nervous system effects.

Chemical	Permissible Exposure Limit	Short-Term Exposure Limit	Reference (1)
Benzene	0.1 ppm v/v 8 hr. TWA (2)	5 ppm v/v 15 min. avg.	29 CFR 1910.1028, ACGIH(4)
Ethylene dibromide	ALARA (3)	ALARA	ACGIH
Gasoline	300 ppm v/v 8 hr. TWA	500 ppm v/v 15 min. avg.	ACGIH

#### Note:

- (1) Per DOE Order 5480.4.
- (2) 8-hour time weighted average exposure, ACGIH Notice of Intended Changes for 1993-1994.
- (3) "As Low As Reasonably Achievable," per ACGIH Guidelines for Suspected Human Carcinogens.
- (4) American Conference of Governmental Industrial Hygienists.

#### 4.3 Chemical -- Dermal (Skin) Contact:

- 4.3.1 Gasoline: Skin contact with gasoline components, as with other organic solvents, can remove essential oils from the skin, causing localized inflammation, cracking, and/or bacterial infections, referred to collectively as solvent dermatitis.
- 4.3.2 Hydrogen Peroxide: Hydrogen peroxide (50%) is a strong oxidizer. Burns will be produced upon contact with the liquid.
- 4.4 Thermal Exposure: System piping which conducts heat from steam flow can produce thermal burns if left uninsulated. (See reference 11.2)
- 4.5 Confined Space: Injury may occur while entering, working in and leaving baker tanks. The two baker tanks are open top, 12 feet high and can contain 20,000 gallons each. Baker tanks may contain ground water contaminated with gasoline during start up testing.
- 4.6 Noise: Injury may occur due to continuous noise exposure from operating fans and blowers and the internal combustion engine.
- 4.7 Electrical: Injury may occur if LVB-60 panel door is open and contact is made with energized electrical components.
- 4.8 Non-ionizing Radiation: The LVB-60 unit contains a number of quartz-tube type ultraviolet lamps. Ultraviolet radiation can cause skin burns and eye damage. Chronic exposures to certain wavelengths of ultraviolet light are associated with increases in skin cancer rates.

## 5.0 Controls

The controls specified below will reduce risk to employees and the environment to acceptable levels:

- 5.1 Fire/Explosion: Fire/explosion control is accomplished by eliminating ignition sources in areas with potential gasoline vapor concentration between the LEL and UEL. Fire extinguishers (carbon dioxide or dry chemical, type BC or ABC) shall be available on site.
  - 5.1.1 Only explosion proof or intrinsically safe equipment is to be used within the extraction wells, within the piping to the oil/water separators including the ground water heat exchanger and air/water separator. Explosion proof or intrinsically safe equipment is also required within the condenser, demister, condensate return tank and piping from these components to the liquid treatment system. Explosion proof or intrinsically safe equipment is also required within the oil/water separator and gasoline storage tank(s).
  - 5.1.2 The oil/water separator has a lid which must be opened to visually check for proper operation. Vapors are exposed to atmosphere at this location only for

treatment equipment. The area within 3 horizontal feet of the oil/water separator or gasoline storage tank(s) is Class 1 Division 1. The area within 3 to 10 horizontal feet of the oil/water separator or gasoline storage tank(s) is Class 1 Division 2. Electrical equipment within these area conforms to the appropriate requirements.

- 5.1.3 Operations outside of this OSP (Ref. 11.2) may produce gasoline vapors in the vicinity of treatment equipment. Monitoring with an approved LEL meter shall be conducted during any operation which may produce explosive concentrations of gasoline. If concentrations of 0.1 LEL (1,000 ppm) or greater are found, all operations will cease, the area shall be evacuated and fire department shall be phoned on 911.
- 5.1.4 Electrical design and construction of the vapor extraction system (VES, Ref. 11.3) shall meet the general requirements of NFPA-70, and all electrical control devices shall comply with NEMA ICS-2. Safety devices shall include improper-operation interlocks, overload relays, and circuit breaker disconnects. Fire protection system shall include hydrocarbon sensor for flammable vapors and automatic fire detection/suppression.
- 5.1.5 Smoking shall not be permitted inside the controlled area. An adequate number of "NO SMOKING" signs shall be posted throughout the project area.

## 5.2 Chemicals -- Inhalation:

- 5.2.1 Warning signs with the following wording shall be placed on the perimeter fence so that they are clearly visible from any approach:

**DANGER  
BENZENE  
CANCER HAZARD  
FLAMMABLE -- NO SMOKING  
AUTHORIZED PERSONNEL ONLY  
RESPIRATORS REQUIRED**

The portion of the sign that reads "Respirator Required" shall be covered unless airborne benzene concentrations exceed the limits specified in 5.2.2.1 and 5.2.2.2.

- 5.2.2 All maintenance operations shall be monitored to assess possible exposures, until sufficient replicate monitoring data is collected to permit the accurate characterization of potential exposures. Until exposures are fully characterized, all operations involving the opening of normally sealed separation and/or treatment equipment shall be performed following the procedures outlined in Section 5.2.2.3.



5.2.2.1 The ES&H Team 4 Industrial Hygienist shall be notified in advance of all routine or scheduled maintenance operations to permit the deployment of personal air sampling equipment. If exposure to benzene in excess of 5 ppm v/v measured as a 15 minute Time-Weighted Average (TWA), or 0.1 ppm v/v measured as an 8 hour TWA are detected, or if exposures to other chemical agents are detected in excess of their published Threshold Limit Values, the procedures outlined in Section 5.2.2.3 shall be instituted.

5.2.2.2 Unless otherwise instructed by ES&H Team 4, site personnel shall conduct breathing zone monitoring during all maintenance operations, both routine and emergency, using a photoionization detector (PID) equipped with Organic Vapor Monitor (OVM). The OVM does not provide chemical-specific measurements; however, all measurements made will be treated as if the equivalent levels of benzene were present (i.e., the "worst case" exposure scenario will be used). When equipped with a 10.0 electron volt (eV) lamp, the OVM should either (a) be calibrated to directly read benzene concentrations or (b) is set with an instrument response factor of 0.7; for other lamps, the instrument must be calibrated to directly read benzene concentrations. When benzene exposures exceed 5 ppm for a period of one minute, the operation shall be suspended, ES&H Team 4 shall be notified immediately, and the controls specified in Section 5.2.2.3 are instituted.

5.2.2.3 Respiratory Protection:

5.2.2.3.1 All personnel working within the regulated work area shall don appropriately fitted full-facepiece respirators equipped with organic vapor cartridges, and disposable (Tyvek) coveralls.

5.2.2.3.2 The "Respirators Required" portion of the benzene warning signs posted at each entrance to the regulated work area shall be uncovered.

5.3 Chemicals -- Dermal (Skin) Contact:

Eye wash/shower stations shall be available within 10 seconds and 100 feet of travel for all areas where chemical splash may occur. Personnel shall be instructed to orient themselves to the nearest eyewash/shower station prior to performing maintenance work. A first aid kit shall be available on site.

5.3.1 Gasoline:

5.3.1.1 When the possibility of skin contact with pure gasoline (free product) occurs, personnel shall wear safety glasses, full face shields, Tyvek coveralls and neoprene or nitrile (Buna-N) gloves.

5.3.1.2 When the possibility of skin contact with ground water contaminated with gasoline occurs, personnel shall wear exam weight polyvinyl chloride or latex gloves and safety glasses. If systems being worked on are pressurized, faceshields shall be worn as a supplement to the safety glasses.

#### 5.3.2 Hydrogen Peroxide:

5.3.2.1 When the possibility of skin contact with 50% hydrogen peroxide occurs, personnel shall wear safety glasses, face shield, neoprene or nitrile gloves and Tyvek coveralls or plastic apron. A copy of the Material Safety Data Sheet (MSDS) for the hydrogen peroxide used shall be available on-site at all times.

5.3.2.2 To maintain a low hazard classification for Treatment Facility F, no more than 700 gallons of hydrogen peroxide ( $H_2O_2$ ) will be stored at the site at any time.

The existing  $H_2O_2$  feed tank has a 200 gallon capacity. The  $H_2O_2$  "Tote" delivery containers have a 330 gallon capacity. The total  $H_2O_2$  volume in all tanks will be maintained below the 700 gallon limit.

For logistical reasons and because TFF is located next to the Lab's shipping and receiving facility, the  $H_2O_2$  vendor may at times bring two or three totes onto the TFF site for distribution to other ground water treatment facilities throughout the Lab. This "distribution" handling will not exceed a few hours duration.

#### 5.4 Thermal Exposure:

All exposed system components capable of producing burns shall be insulated. If insulation of some components is not practical, and requires handling or can be contacted inadvertently, proper protective equipment such as heat insulating gloves shall be worn.

#### 5.5 Confined Space:

5.5.1 Entries into confined spaces shall be performed in compliance with *Health & Safety Manual*, Supplement 26.14 and Occupational Safety and Health Administration (OSHA) requirements for confined space entry (29 CFR 1910.146). In advance of any entries into confined spaces, ES&H Team 4 shall be consulted to determine the procedures required. Depending on the space

being entered and the history of contamination the space may be classified as either an OSHA Non-Permit Confined Space (LLNL equivalent "Low Hazard Confined Space") or an OSHA Permit Required Confined Space (LLNL equivalent "High-Hazard Confined Space").

- 5.5.2 Ladders are removed from Baker Tanks and secured with a chain and keyed lock. The key is stored in a lock box in Building 406.

5.6 Noise:

- 5.6.1 Noise surveys indicate that hearing protection is required when working within 10 feet of the internal combustion engine for 4 hours or more.

- 5.6.2 The entrance to these areas shall be posted with "Noise Hazard" warning signs.

- 5.6.3 If 8-hour Time weighted Average noise exposures are projected to approach or exceed 85 dBA, the following controls shall apply:

- LLNL and Supplemental labor personnel shall be enrolled in the LLNL Hearing Conservation Program.
- Other subcontractors shall be notified of the presence of potentially hazardous noise levels and advised to enroll employees in the company's Hearing Conservation Program.
- All employees shall wear hearing protection when working within designated noise hazardous areas.

5.7 Electrical:

Interlock system and panel doors with keyed locks prevent contact with energized electrical components. Keys to panel door locks are kept in a lock box at Building 406. If maintenance or use of equipment requires entry into areas of exposed wiring, general lock and tag procedures outlined in *Health & Safety Manual*, Supplement 26.13 "General Lock and Tag Procedure" shall be followed.

5.8 Non-ionizing Radiation:

The ultraviolet lamps in the LVB-60 unit are completely enclosed, precluding ultraviolet light exposures from occurring during normal equipment operations. The interlocks which prevent the unit from operating while open, combined with the Electrical control measures outlined in Section 5.7 will prevent exposure from occurring during maintenance operations.

## 6.0 Environmental Concerns and Controls

- 6.1 Release of gasoline or ground water contaminated with gasoline to ground is an environmental concern. All treatment system piping is above ground. Operations personnel shall monitor the equipment and piping and shut down the facility if a leak should occur. Refer to section 10, "Emergency Response Procedure."

### 6.2 Release of Gasoline Contaminated Water to Cooling Towers:

TFF is equipped with interlocks which shut down the system, including pumps, upon failure of the oil/water separator, high water temperature, failure of LVB-60, blower failure and air supply pipe to air stripper failure. Concentration of total toxic organic (TTO) to the cooling towers is  $< 5 \mu\text{g/L}$ . Approximately 95% of the water sent to the cooling towers is evaporated. The remaining 5% is blown down to sanitary sewer. Allen Grayson informs us that the Livermore Water Reclamation Plant (LWRP or sanitary sewer) allows this discharge. The limit for the LWRP is  $1,000 \mu\text{g/L}$ . The LWRP limits the sum of benzene, ethyl benzene, toluene and xylene to  $250 \mu\text{g/L}$ .

### 6.3 Release of Gasoline Vapors to the Atmosphere:

TFF has an amended permit (No. 1464) to operate from the Bay Area Air Quality Management District. Water is treated by oil/water separation, UV- $\text{H}_2\text{O}_2$  oxidation and air stripping. Soil vapors are treated by internal combustion engine oxidation and/or carbon with steam regeneration. Carbon is also used for vapors from the air/water separator, gasoline storage tank and the transfer tank to prevent release to the atmosphere.

### 6.4 Waste Management:

In the course of operating this facility, free gasoline product will be generated. HWM shall select a contractor to recycle/dispose of gasoline collected. Contaminated filters shall be handled by HWM personnel and procedures.

## 7.0 Training

- 7.1 All authorized operators shall have completed the following safety courses:

HS-0039 - "SARA/OSHA Training" (40 hour course with 8 hour refreshers every year).

HS-4610 and HS-4611 before respirators are used.

HS-4660 for personnel acting as respirator custodians.

HS-4360 - "Noise" if 8 hour TWA noise exposures exceed 85 dBA.

- 7.2 All personnel who generate hazardous waste are required to attend the following Environmental Protection Department course (this course must be requested):

EP-0006 - "Hazardous Waste Handling Practices"

It is permissible for personnel who have not attended the required course to work under the direction of a person who has completed the course for an interim period, not to exceed 90 days.

- 7.3 All personnel shall attend a pre-start safety meeting to review the operation and the requirements of this OSP. If necessary this safety meeting will be expanded to provide some of the training required in 7.1, above.
- 7.4 The following courses are recommended. Individual courses shall be required as the responsible individual determines necessary. Reading individual references (Section 11) shall be required as the Responsible Individual determines necessary.

HS-1620 - "Standard First Aid"

HS-1640 - "Cardiopulmonary Resuscitation (CPR)" repeated every 2 years.

HS-1680 - "Fire Extinguisher Training"

HS-4050 - "Health Hazards Communication"

HS-4150 - "Confined Space Entry"

HS-4240 - "Chemical Safety"

HS-5030 - "Pressure Safety Orientation"

HS-5210 - "Capacitor Safety Orientation"

HS-5220 - "Electrical Hazards Awareness"

HS-5230 - "High Voltage Safety"

HS-5300 - "Back Care Workshop"

HS-6010 - "Radiation Safety"

- 7.5 The Responsible Individual shall ensure that all required training, including on-the-job training if applicable, is complete and documented.

## 8.0 Maintenance

Items requiring periodic maintenance do not impact the safety of the operation. Maintenance items which have the potential to impact environmental release include: silt in the oil/water separator, replacing the 5 micron particulate filter, cleaning and monitoring the LVB-60 UV-hydrogen peroxide machine and fouling the air to water ports in the air

stripper. These items will be monitored and maintenance performed as necessary (Ref. 11.4).

## **9.0 Quality Assurance**

Scheduled weekly, monthly, quarterly and annual sampling and analysis insure compliance and quality. This data will be analyzed by the remediation engineer to monitor performance and verify compliance with permits.

## **10.0 Emergency Response Procedures**

10.1 In case of fire or imminent threat to health and safety, phone the Fire Department at 911.

10.2 When in doubt about handling a spill, phone the Fire Department at 911.

Small spills may be cleaned up by operators if:

- The identity of spilled material is known.
- The material is commonly handled by the operators and operators are familiar with its hazards, and;
- The spill will take two people less than one hour to clean up.

10.3 The ES&H Team Health and Safety Technician shall be notified of all spills.

## **11.0 References**

11.1 *Health & Safety Manual*, M-010.

11.2 OSP No. L-52 "Clean Up of Ground Water Contaminated With Gasoline by Using the Dynamic Underground Stripping Process."

11.3 ERD91-0001 "Vapor Extraction System With Carbon Regeneration".

11.4 "Operating and Maintenance Manual, Perox-Pure Oxidation System", LVB-60, Peroxidation Systems, Inc.

11.5 29 CFR 1910.1028.